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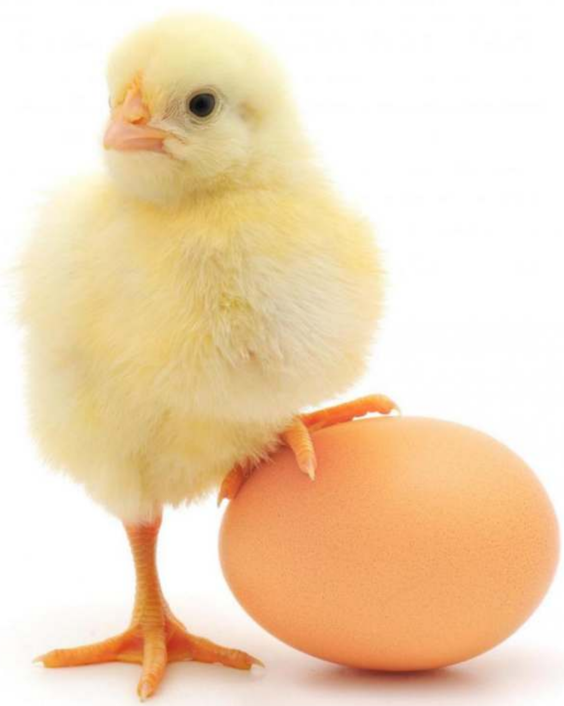

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Protein Intake of Growing Indigenous Chickens on Free-Range and Their Response to Supplementation

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Abstract: Three experiments were conducted to determine protein intake and the response of growing indigenous chickens to protein supplementation under free-ranging conditions. In the first experiment, data were collected from which a model was designed to estimate daily feed intake of free-ranging indigenous chicken from the Crop Contents (CC). The second experiment applied the model under on-farm conditions to estimate feed intake of free-ranging growers. Crude Protein (CP) intake was calculated as the product of crude protein concentration and total intake of feed. Results indicated that the mean protein level of CC was 11.2%, Dry Matter Intake (DMI) of free-ranging growers was 78.3g/grower/day and the mean Crude Protein Intake (CPI) was about 8.5 g. In order to establish the response of the growers to protein supplementation in an on-farm set-up, the third experiment provided protein supplements at 0, 1.6, 3.2 and 4.8 g CP/bird/day. Daily CPI for each of the four supplementary groups was calculated to be 8.5, 10.1, 11.7 and 13.3 g/bird. Growth rate and body weight increased with increasing protein supplementation up to 3.2 g CP/bird/day. Higher levels of protein supplementation did not significantly increase growth rate or body weight. Therefore, the CP requirement for growing indigenous chickens on free-range was estimated at 11.7 g/day. Protein supplementation of 3.2 g/bird/day to a growing indigenous chicken on free-range is therefore mandatory for optimum growth.

Key words: Indigenous chickens, protein requirements, scavenging, protein intake

Introduction

Poultry meat and egg production accounts for more than 30% of the animal protein consumption globally and the share is increasing steadily (Guéye, 1998). In most developing countries, poultry production is mainly based on indigenous ecotypes and scavenging backyard production systems. In western countries, animal welfare activists are campaigning against intensive poultry production due to stresses the birds are subjected to in terms of lack of exercise (Savory, 2003). Although the trend in Kenya is towards intensive poultry production, the trend worldwide is to increase productivity under free-range systems. It is estimated that there are about 20.8 million indigenous chickens that produce 52% and 43.5% of the total poultry meat and eggs, respectively (MOL and FD, 2003). Over 90% of all poultry comprise the indigenous chickens and are found in almost all rural households. These birds adapt well to different environments and can survive on limited feed resources which fluctuate in quality according to seasons.

In many sub-Saharan countries of Africa, indigenous chickens are characterized by low productivity due to poor nutrition, prevalence of diseases and lack of sound management (Musharaf, 1990) and are invariably reared under scavenging conditions. The nutrient intake of these chickens from the scavenging resource base is mostly sufficient for maintenance and low production, but for increased production, additional inputs are needed (Dessie, 1996). Improvement in the performance of indigenous birds on free-range requires some knowledge of feed available to them under the prevailing systems of production. This will allow for an evaluation of their nutritional status and possible formulation of a supplementary package. Kingori *et al.* (2003) determined the protein requirement of growing indigenous chickens in Kenya under confinement. The present study was designed to estimate protein intake and requirement by free-range indigenous growers.

Materials and Methods

Experiment 1: In this experiment, thirty two indigenous hens were used. All the hens were individually housed in battery cages and given a 14-day adaptation period. Daily feed intake was thereafter recorded over three consecutive days. The mean daily intake was then considered to be the *ad libitum* intake level of the hens for the three days. The hens were then randomly allocated four treatments (diets) that reflected the type of feed and its availability under free-range conditions.

During the experimental period, intake of the four diets was determined between 6.00 hrs and 18.00 hrs. The free-range diet was one containing maize grain, *ugali*, green vegetation, grit, unidentifiable material and insects in various proportions as described by Birech (2002) in Table 2.

Table 1: Experimental treatments and their description

Trt.	Description
1	*Ad libitum* offer of a layers' conventional diet
2	*Ad libitum* offer of free-range type of diet
3	Restricted offer of free-range type of diet at 70% *ad libitum*
4	Restricted offer of free-range type of diet at 80% *ad libitum*

Trt. = Treatment

Table 2: Composition of the free-range diet

Ingredients	Observations	% composition	S.D
Maize grain	120	54	28.5
Ugali*	120	14	23.3
Green vegetation	120	15	20.0
Grit	120	2	5.0
Unidentifiable material	120	9	11.3
Insects	120	6	13.6

*Ugali = cooked maize meal

Table 3: Chemical composition (g/kg) of the protein supplement used in the experiment

Component	g/kg
Dry matter	922.9
Crude protein	398.0
Ether extract	90.9
Ash	124.6
Crude fibre	247.2
Nitrogen free extracts	62.2

The four treatments were allocated to the four groups as follows; Groups 1 and 2 received an *ad libitum* offer of a conventional layers' mash and free-range diets, respectively. Group 3 and 4 each received a restricted offer of the free-range type of diet (70% and 80%, respectively) that was provided in hourly portions between 6.00 hrs and 17.30 hrs. Clean drinking water was availed throughout the day. Feed consumption was determined as the difference between the feed offered at 6.00 hrs and left-over at 18.00 hrs. The hens were slaughtered to remove the CC at the end of the feeding day (18.00 hrs). Daily Dry Matter Intake (DMI) and CC were estimated on dry matter basis. A regression equation was then developed to describe the relationship between the CC and DMI using the procedures of the Statistical Analysis System (SAS, 1996).

On farm trials: Two on-farm experiments were conducted in two phases between April 2001 and August 2002. Twenty farmers were recruited from Kihingo Location of Nakuru district. The area is a medium to high potential zone on the eastern slopes of the Mau ranges in the Rift Valley Province of Kenya. The farmers in this region practice mixed farming with major crops being maize, wheat, beans, peas, potatoes and pyrethrum. Livestock kept include cattle, sheep and poultry (chickens, ducks and turkeys). Indigenous chickens are kept under a free-range system.

Experiment 2: In this experiment, the regression equation derived from the first experiment was used to estimate feed intake of grower hens on free-range. The dry weight of the CC obtained at 18.00 hrs from one hundred and eight such birds on free-range was fitted into the regression equation to obtain an estimate of their DMI. Sampling was done in 10 farms over a period of one year in order to capture seasonal changes in feed availability. The flocks targeted for sampling were those predominantly on free-range (scavenging). The CC collected after sacrificing the grower hens at 18.00 hrs was then freeze dried in preparation for proximate analysis using the standard procedures of the Association of Official Analytical Chemists (AOAC, 1995). Crude protein intake per day was calculated as the product of DMI and percent CP in the CC. All data were subjected to the analysis of variance according to Steel and Torrie (1980) and significant means were separated using the LSD.

Experiment 3: One hundred and twenty indigenous grower chickens aged 13 weeks old were used in the experiment. The growers were reared at the Kenya Agricultural Research Institute in Naivasha using a commercial ration from day-old to 13 weeks of age. They were then randomly distributed among the 20 farmers, where each farmer got 6 growers (3 cockerels and 3 pullets). These were housed either in the farmer's house or in simple wooden structures with or without wire mesh for ventilation. No bedding was provided. All the birds on each of the farms were vaccinated against Newcastle disease.

All the four dietary treatments were randomly allocated among the 20 farmers, forming 5 replicates. The grower chickens were allowed to scavenge for feed around the homestead. Over and above this, they were also offered 0, 4, 8 and 12 g of a protein supplement daily (in the mornings) as treatments 1, 2, 3 and 4, respectively, for a period of 12 weeks. These quantities of supplements were calculated to correspondingly supply 0, 1.6, 3.2 and 4.8 g CP/bird/day. Water was provided *ad libitum*. The proximate composition of the protein concentrate is shown in Table 3.

Total protein intake after supplementation was calculated as the sum of protein intake from scavenging (8.5 g) and the protein supplied through the supplements offered, i.e., 0, 1.6, 3.2 and 4.8 g. The growing chickens were weighed on a weekly basis and the growth rate computed. All data were subjected to analysis of covariance with initial weight as the co-variable (Minitab, 1996). Each farm was used as the experimental unit. Where the F-test was significant ($p<0.05$), the LSD method (Steel and Torrie, 1980) was used to separate the means.

Table 4: Effect of protein supplementation on growth rate and chicken weight

	Diet				
Parameter[1]	1	2	3	4	LSD
CPI[2]	8.5	8.5	8.5	8.5	
Supplement (g/bird/day)	0	1.6	3.2	4.8	
Total CPI (g/bird/day)	8.5	10.1	11.7	13.3	
Weight gain (g/bird/day)	4.96^{c}	11.31^{d}	13.41^{a}	11.31^{b}	0.232
Final chicken weight (g)	1115.6^{c}	1406.7^{b}	1541.3^{a}	1455.1^{b}	66.91

[1]Each represents an average of five measurements, [2]Crude protein intake from scavenging (g/bird/day), [a,b,c]Means within a row with different superscripts are significantly different ($p < 0.05$)

Table 5: Effect of crude protein supplementation on body weight (g) of indigenous chickens 13-25 weeks old

	Level of protein CP/bird/day (g)					
	CP - scavenging	8.5	8.5	8.5	8.5	
	CP - supplement	0	1.6	3.2	4.8	
Age (wk)	Daily CP intake	8.5	10.1	11.7	13.3	SD
14		918	984	938	959	28.31
15		931	1036	1138	1041	84.56
16		931	1134	1278	1189	147.16
17		968	1232	1334	1239	157.21
18		1044	1298	1448	1343	171.44
19		1084	1396	1518	1393	185.22
20		1171	1448	1684	1513	213.31
21		1194	1534	1697	1691	235.74
22		1234	1594	1747	1772	247.98
23		1276	1684	1888	1719	259.59
24		1311	1742	1930	1737	261.89
25		1296	1800	1964	1805	290.33

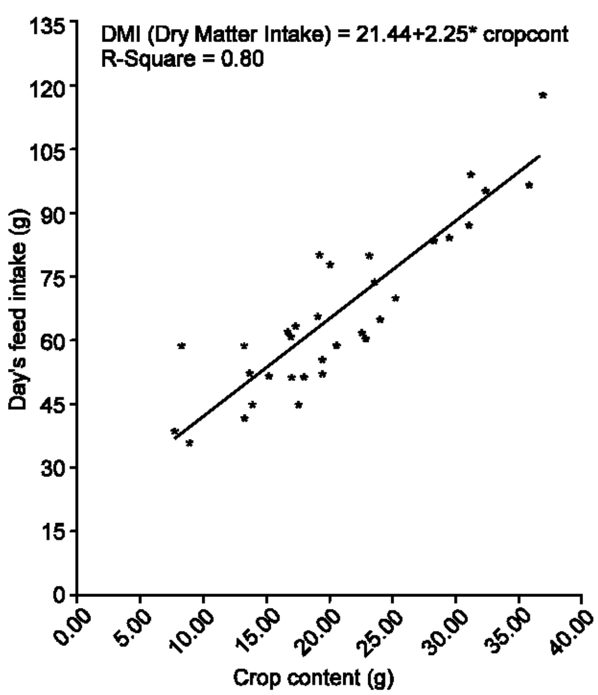

Fig. 1: Regression of dry matter intake on crop contents recovered at 18.00 hrs

Results

There was a positive linear association with a correlation coefficient (r) of 0.89 between the amount of feed offered and that found in the crop. The best line of fit describing this relationship had a coefficient of determination (r^2) of 0.80 (Fig. 1). The following regression equation was obtained; DMI (g/bird/day) = 21.44 + 2.25 * CC (g).

When this equation was used to estimate feed intake of grower hens in the field, estimated DMI was 78.3 g/bird/day. No significant seasonal or farm variations were observed. The mean CP level in the CC of these birds was 11.2%. These estimates were then used in calculating CPI of the grower hens on free-range where mean CPI/bird/day was 8.5 g. In the on-farm supplementary trial, CPI/ grower hen /day for treatments 1, 2, 3 and 4 were estimated at 8.5, 10.1, 11.7 and 13.3 g, respectively. The performance of the chickens as a result of supplementation is shown in Table 4 and 5.

Growth rate and therefore chicken weights, increased ($p<0.05$) with increasing level of supplementation up to 3.2 g CP/bird/day then decreased (Table 4). Supplementation levels of 1.6 and 4.8 g CP/day gave similar ($p>0.05$) growth rates and chicken weights. The growers receiving no supplement had the lowest growth rate and body weight (Table 5).

Discussion

The regression equation relating the crop content and feed intake for scavenging chickens indicate that they have a higher intake than those in confinement (Kingori *et al.*, 2003). This could be attributed to the nature of the scavenged feed, nutrient content and the nutrient requirement for scavenging. Protein synthesis and consequently growth, depends directly on protein supply (Blum *et al.*, 1975). The present experiment studied feed and nutrient intake of local grower hens in Nakuru district of Kenya where their CPI on free-range was 8.5 g. On the other hand, Kingori *et al.* (2003) reported a CP requirement of 10.9 g per day for indigenous chickens of the same age under confinement. Therefore, the apparent CPI of indigenous growers under scavenging conditions is below their requirements. It was therefore deduced that they currently have a CP deficit of about 2.4 g/day. This deficit limited their growth as evidenced from the results of the present experiment where growth rate and live weight of the chickens increased ($p<0.05$) between CPI of 8.5 and 11.7 g/bird/day then decreased. Similar trends were observed when growing indigenous chickens under confinement had CPI between 3.1 and 10.9 g/bird/day (Kingori *et al.*, 2003). It is, however, worth noting that comparative requirements for these chickens under confinement and free-range are slightly different. The CP requirements for chickens under scavenging conditions appeared to be higher than under confinement although they were quite close (11.7 vs 10.9 g). This may be attributed to higher maintenance requirements on free-range by virtue of increased scavenging activity.

In a stress free environment and given adequate intake of essential nutrients, growth increases until a genetically determined limit is reached (Campbell and Taverner, 1988). Protein deficiency in a feed reduces growth while feeding above protein requirements does not increase growth (Bikker *et al.*, 1994). This was demonstrated in this study by the growth rates and the live weights of the birds consuming 8.5-13.3 g/day/bird. Protein intake below 11.7 g resulted in reduced growth rate while intake above it did not increase growth ($p<0.05$), suggesting inefficiency of protein utilization. When the supply of protein is in excess of the requirement, nitrogen excretion increases (Bikker *et al.*, 1994). However, protein deficiency in a feed reduces growth as a result of depressed appetite and intake of nutrients. When there is a dietary protein deficit, the free amino acid patterns of both muscle and plasma become imbalanced and consequently trigger the appetite regulating system to reduce feed intake (Harper and Rogers, 1965). This may be the scenario when free-range growers receive inadequate supply of protein or utilize diets with an imbalanced ratio or proportion of amino acids.

The live weight of the chickens (25 weeks old) in this study (Table 5) were similar to those reported for indigenous chickens in Sri Lanka (1516 g) (Gunaratne *et al.*, 1993), Kenya (1273 g-1318 g) (Chemjor, 1998; Birech, 2002) and Tanzania (1348 g) (Mwalusanya, 1998). Stotz (1983) reported 1750 g for indigenous chickens in Kenya at 24 weeks of age, which is close to the weights of chickens in this study that were offered 10.1 g and 13.3 g CP daily and weighed 1742 and 1737 g, respectively, at the same age. The chickens in this study that were offered 11.7 g CP were heavier (Table 5) than 1750 g reported by Stotz (1983). The differences in the weights reported for the indigenous chickens by the different authors may be due to differences in their nutritional status (whether offered protein supplementation or not). The chickens in the current study were reared on chick starter diet for the first eight weeks and then growers' diet up to the 13th week. They were therefore likely to be heavier than those that scavenged throughout.

Indigenous chickens normally have lower growth rate and mature body weights than commercial growers but with protein supplementation, they might attain similar growth rate and mature body weights as commercial layer type chickens. Indigenous chicken flocks have hardly been improved by genetic manipulation and there has been no systematic breeding program unlike the case with commercial-type chickens. The regression equation relating the crop content and feed intake gives a useful estimate of the feed intake under scavenging conditions. In general, protein supplementation to growing indigenous chickens on free-range is mandatory for optimum growth. The results of this study demonstrated that growing scavenging indigenous chickens require CP supplementation of 3.2 g/bird/day or CP intake of 11.7 g/bird/day during the 14-25 week growing period.

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